

*Hyocrinus bethellianus*, sp. n.

*H. bethellianus*?

The last is a beautiful little thing which we dredged from a depth of 2325 fathoms at Station 223, lat. 5° 31' N., long. 145° 13' E., in the east Pacific, with a bottom of *Globigerina*-ooze, and a bottom-temperature of 1°·2 C. It certainly is in many respects very unlike the adult *H. bethellianus*; but it may possibly turn out to be the young of that species. There was only one specimen.

It has been found impossible, or at all events too dangerous, to examine and compare the species belonging to the Pentacrinidæ on board; many of the specimens are very large, and they are very tender, requiring the utmost delicacy in handling; it has therefore been thought in most cases advisable to pack them away in safety at once, and to defer their discrimination until our return home.

'Challenger,' South Atlantic,  
March 5th, 1876.

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Notice of some Peculiarities in the Mode of Propagation of certain Echinoderms of the Southern Sea. By Sir C. WYVILLE THOMSON, LL.D., D.Sc., F.R.S., F.L.S., F.G.S., &c., Regius Professor of Natural History in the University of Edinburgh, Director of the Civilian Scientific Staff of the 'Challenger' Exploring Expedition.

[Read June 1, 1876.]

THE very remarkable mode of reproduction of certain members of all the recent classes of Echinodermata by the intervention of a free-swimming bilaterally symmetrical "pseudembryo" developed directly from the "morula," from which the true young is subsequently produced by a process of internal budding or rearrangement, has long been well known through the labours of a host of observers headed and represented by the late illustrious Professor Johannes Müller of Berlin.

At the same time it has all along been fully recognized that reproduction through the medium of a "pseudembryo" is not the only method observed in the class, but that in several of the Echinoderm orders, while in a certain species a wonderfully perfect and independent bilateral locomotive zooid may be produced, in very nearly allied species the young Echinoderm may be developed im-

mediately from the segmented yelk without the formation of a "pseudembryo," or at all events with no further indication of its presence than certain obscure temporary processes attached to the embryo, to which I have elsewhere (Phil. Trans. for 1865, p. 517) given the name of "pseudembryonic appendages."

I have not at present an opportunity of consulting authorities; but if I may trust my memory, this direct mode of development has been described in *Holothuria tremula* by MM. Koren and Danielssen, in *Synaptula vivipara* by Professor Oersted, in a "viviparous sea-urchin" by Professor Grube, in *Echinaster* and in *Pteraster* by Professor Sars, in *Asteracanthion* by Professor Sars, Professor Agassiz, Dr. Busch and myself, in *Ophiolepis squamata* by Professor Max Schultze, and in "a viviparous ophiurid" by Professor Krohn. No less than four of these observations were made on the coast of Scandinavia. In temperate regions, where the economy of the Echinoderms has been under the eye of a greater number of observers, the development of the free-swimming larva appeared to be so entirely the rule that it is usually described as the normal habit of the class; while, on the other hand, direct development seemed to be most exceptional. I was therefore greatly surprised to find that in the southern and subarctic seas a large proportion of the Echinoderms of all orders, with the exception perhaps of the Crinoids (with regard to which we have no observations), develop their young after a fashion which precludes the possibility, while it nullifies the object, of a pseudembryonic perambulator, and that in these high southern latitudes the formation of such a locomotive zooid is apparently the exception.

This modification of the reproductive process consists in all cases, as it does likewise in those few instances in which direct development has already been described, of a device by which the young are reared within or upon the body of the parent, and are retained in a kind of commensal connexion with her until they are sufficiently grown to fend for themselves. The receptacle, in cases where a special receptacle exists in which the young are reared, has been called a "marsupium" (Sars), a term appropriately borrowed from the analogous arrangement in their neighbours the aplacental mammals of Australia. The young do not appear to have in any case an organic connexion with the parent; the impregnated egg from the time of its reaching the "morula" stage is entirely free; the embryos are indebted to the mother for pro-

tection, and for nutrition only indirectly through the mucus exuded from the surface of her perisom, and through the currents of freshly aerated water containing organic matter brought to them or driven over them by the action of her cilia.

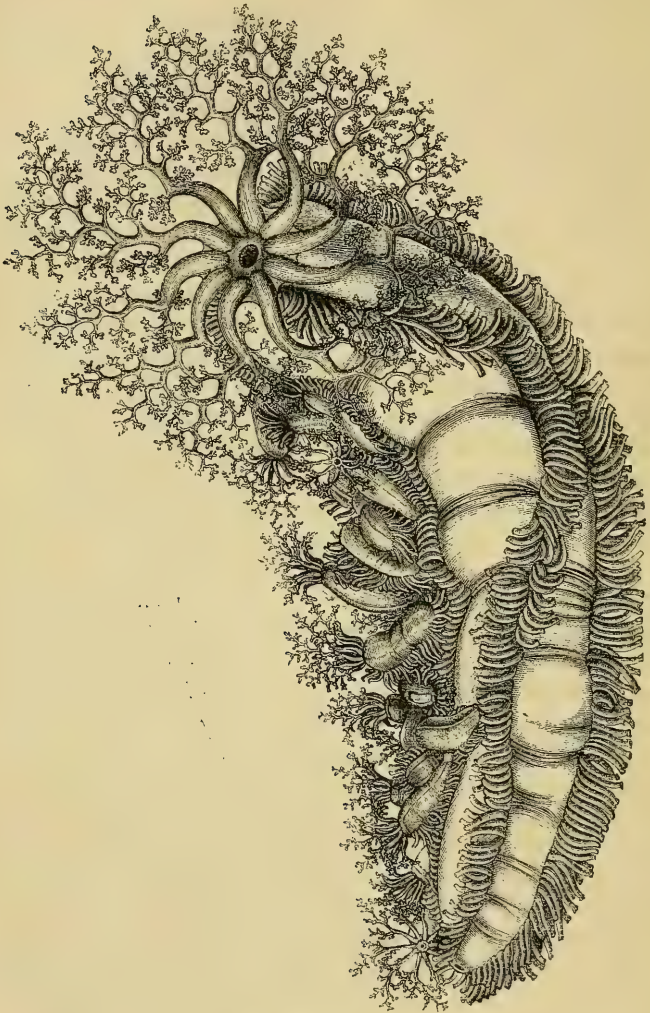
Animals hatching their eggs in this way ought certainly to give the best possible opportunities for studying the early stages in the development of their young. Unfortunately, however, this is a kind of investigation which requires time and stillness and passable comfort; and such are not the usual conditions of a voyage in the Antarctic sea. Specimens have been carefully preserved with the young in all stages; and I hope that a careful examination of these may yield some further results.

Although the principle and the leading features of the process are the same in all, the details vary greatly in the different groups. My present object is to give a preliminary sketch of some of the more remarkable modifications. In the absence of a sufficient supply of books of reference, I cannot vouch for the accuracy of specific determinations; the names which I have given to the species referred to must therefore be taken in some cases as provisional. I will select examples from the leading groups in order.

#### I. HOLOTHUROIDEA PEDATA.

*Cladodactyla crocea*, Lesson, sp. (fig. 1). An elegant cucumber-shaped sea-slug, from 80 to 100 millims. in length, by 30 millims. in diameter at the widest part, of a bright saffron-yellow colour, very abundant, adhering to the vast fronds of *Macrocystis* in from five to ten fathoms water in Stanley Harbour at East Falkland Island. The mouth and arms are terminal; ten long delicate branched oral tentacles, more resembling in form and attitude those of *Ocnus* than those of the typical *Cucumariæ*, surround the mouth: the perisom is thin and semitransparent; and the muscular bands, the radial vessels, and even the internal viscera can be plainly seen through it. The three anterior ambulacral vessels are approximated; and on these the tentacular feet are numerous and well developed, with a sucking-disk supported by a round, cribriform, calcareous plate, or more frequently by several wedge-shaped radiating plates arranged in the form of a rosette; and these three ambulacra form together, at all events in the female, a special ambulatory surface. The two ambulacral vessels of the bivium are also approximated along the back; and thus the two inter-ambulacral spaces on the sides of the animal, between the external

Fig. 1.

*Cladodactylia crocea*, Lesson.

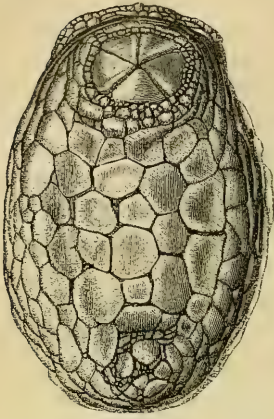
Natural size.

trivial ambulacra and the ambulacra of the bivium, are considerably wider than the other three; consequently, in a transverse section, the ambulacral vessels do not correspond with the angles of a regular pentagon, but with those of an irregular figure in which three angles are approximated beneath and two above. In the female the tentacular parts of the dorsal (bivial) ambulacra are very short; they are provided with sucking-disks; but the calcareous support of the suckers is very rudimentary, and the tubular processes are not apparently fitted for locomotion. In the males there is not so great a difference in character between the ambulacra of the trivium and those of the bivium; but the tentacles of the latter seem to be less fully developed in both sexes, and I have never happened to see an individual of either sex progressing upon, or adhering by, the water-feet of the dorsal canals.

In a very large proportion of the females which I examined, young were closely packed in two continuous fringes, adhering to the water-feet of the dorsal ambulacra (fig. 1). The young were in all the later stages of growth, and of all sizes from 5 up to 40 millims. in length; but all the young attached to one female appeared to be nearly of the same age and size. Some of the mothers with older families had a most grotesque appearance—their bodies entirely hidden by the couple of rows, of a dozen or so each, of yellow vesicles like ripe yellow plums ranged along their backs, each surmounted by its expanded crown of oral tentacles; in the figure the young are represented as about half-grown. All the young I examined were miniatures of their parents; the only marked difference was that in the young the ambulacra of the bivium were quite rudimentary, they were externally represented only by bands of a somewhat darker orange than the rest of the surface, and by lines of low papillæ in the young of larger growth; the radial vessels could be well seen through the transparent body-wall; the young attached themselves by the tentacular feet of the trivial ambulacra, which are early and fully developed.

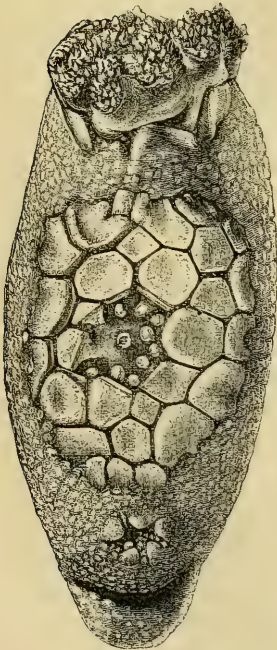
We were too late at the Falklands (January 23) to see the process of the attachment of the young in their nursery, even if we could have arranged to keep specimens alive under observation. There can be little doubt that, according to the analogy of the class, the eggs are impregnated either in the ovarial tube or immediately after their extrusion, that the first developmental

Fig. 2.

Fig. 2. *Psolus ephippifer*, Wy. Thomson.

About three times the natural size.

Fig. 3.

Fig. 3. *Psolus ephippifer*, Wy. Thomson.

About three times the natural size.

stages are run through rapidly, and that the young are passed back from the ovarial opening, which is at the side of the mouth, along the dorsal ambulacra, and arranged in their places by the automatic action of the ambulacral tentacles themselves.

This is one of the cases in which there is no special marsupium formed; it is possible that the comparatively genial conditions of the land-locked fiords and harbours of the Malvinas, and the additional shelter yielded by the imbricating fronds of *Macrocystis*, may render such exceptional provision unnecessary.

On the morning of the 7th of February, 1875, we dredged at a depth of 75 fathoms, at the entrance of Corinthian Harbour (*alias* "Whiskey Bay") in Heard Island (so far as I am aware the most desolate spot on God's earth), a number of specimens of a pretty little *Psolus*, which I shall here call for the sake of convenience *P. ephippifer*, although it may very possibly turn out to be a variety of the northern *P. operculatus*.

*P. ephippifer* (figs. 2, 3) is a small species, about 40 millims. in length by 15 to 18 millims. in extreme width. In accordance with the characters of the genus, the ambulatory area is abruptly defined, and tentacular feet are absent on the upper surface of the body, which is covered with a thick leathery membrane in which calcareous scales of irregular form are imbedded. The oral and excretory openings are on the upper surface, a little behind the anterior border of the ambulatory tract, and a little in advance of the posterior extremity of the body, respectively. A slightly elevated pyramid of five very accurately fitting calcareous valves closes over the oral aperture and the ring of oral tentacles; and a less regular valvular arrangement covers the vent.

In the middle of the back in the female there is a well-defined saddle-like elevation formed of large tessellated plates somewhat irregular in form, with the surfaces smoothly granulated (fig. 2). On removing one or two of the central plates we find that they are not, like the other plates of the perisom, imbedded partially or almost completely in the skin, but that they are raised up on a central column like a mushroom or a card-table, expanding above to the form of the exposed portion of the plate, contracting to a stem or neck, and then expanding again into an irregular foot, which is imbedded in the soft tissue of the perisom; the consequence of this arrangement is that when the plates are fitted together edge to edge, cloister-like spaces are left between their supporting columns. In these spaces the eggs are hatched, and the eggs or the

young in their early stages are exposed by removing the plates (fig. 3). At first, when there are only morules or very young embryos in the crypts, the marsupium is barely raised above the general surface of the perisom, and the plates of the marsupium fit accurately to one another; but as the embryos increase in size, the marsupium projects more and more, and at length the joints between the plates begin to open (fig. 2), and finally they open sufficiently to allow the escape of the young. The young in one marsupium seem to be all nearly of an age. In *P. ephippifer* the marsupium occupies the greater part of the dorsal surface, and its passages run close up to the edge of the mouth, so that the eggs pass into them at once from the ovarial opening without exposure.

In the male there is, of course, no regular marsupium; but the plates are arranged in the middle of the back somewhat as they are in the female, except that they are not raised upon peduncles, so that it is not easy at once to distinguish a male from an infecund female.

Although we have taken species of *Psolus* sometimes in great abundance in various parts of the world, particularly in high latitudes, southern and northern, I have never observed this peculiar form of the reproductive process except on this one occasion.

## II. ECHINOIDEA DESMOSTICHA.

Among the marine animals which we dredged from the steam-pinnace on the 19th of January, 1874, at depths of from 50 to 70 fathoms in Balfour Bay (a fine recess of one of the many channels which separate the forelands and islands at the head of Royal Sound, Kerguelen Land), there were several examples of a small *Cidaris*, which I will name provisionally *C. nutrix*. As, however, in the case of *Psolus ephippifer*, I do not feel by any means certain that this is a distinct species. It comes certainly very near to some of the smaller varieties of *C. papillata*; but as it presents differences which serve at once to distinguish it, and as its peculiar mode of reproduction may perhaps be regarded as in itself a character of specific value, I give it in the mean time the benefit of the doubt.

*C. nutrix* (fig. 4) resembles *C. papillata* in the general form and arrangement of the plates of the corona, in the form and arrangement of the primary tubercles of the interambulacral areas and of the secondary tubercles over the general surface of the test, in the form of the plates of the apical disk and of the im-



bricated calcareous scales of the peristome, in the form, sculpture, and proportionate length of the primary spines, and in the form of the different elements of the jaw-pyramid and in that of the teeth; but the test is more depressed, the secondary spines which articulate to the ambulacral plates and cover the pore-areas are longer and more cylindrical, not so much flattened as they are in *C. papillata*; the large tulip-like pedicellariæ and the long thin tridactyle pedicellariæ mixed with the secondary spines in the northern species are wanting, or in very small number; and the minute pedicellariæ of the peristome are much fewer. The ovaries, which in *C. papillata* have the walls loaded with large expanded calcareous plates, contain only a few small branched

Fig. 4.

*Cidaris nutrix*, Wyv. Thomson.

spicules; and the calcareous bodies in the wall of the intestine are small and distant. The perforations in the ovarian plates in the female are somewhat larger than in *C. papillata*; and the ripe ova in the ovary appear to be considerably larger.

The eggs, after escaping from the ovary, are passed along on the surface of the test towards the mouth; and the smaller slightly spatulate primary spines which are articulated to about the first three rows of tubercles round the peristome, are bent inwards over the mouth, so as to form a kind of open tent in which the young are developed directly from the egg without undergoing any metamorphosis; until they have attained a diameter of about 2·5 millims., they are entirely covered with plates, and are provided with spines exceeding in length the diameter of the test. Even before they have attained this size and development, the more mature or more active of a brood may be seen straying away beyond the limits of the "nursery," and creeping with the aid of their first few pairs of tentacular feet out upon the long spines of their mother; I have frequently watched them return again after a short ramble into the "marsupium."

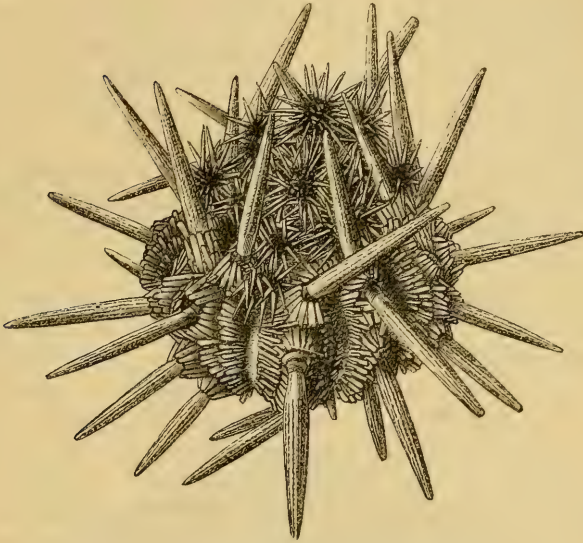
I am not aware that a free pseudembryo, or "pluteus," has been observed in any species of the restricted family Cidaridæ; but I feel very certain that *Cidaris papillata* in the northern hemisphere, except possibly in the extreme north, has no marsupial arrangement such as we find in the Kerguelen *Cidaris*. There have passed through my hands during the last few years hundreds of specimens of the normal northern form, of the Mediterranean varieties, *C. hystrix* and *C. affinis (stokesii)*, and of the American *C. abyssicola*, from wide-spread localities and of all ages; and I have never found the young except singly, and never in any way specially associated with breeding individuals.

The genus *Goniocidaris* (Desor) seems to differ from the genus *Cidaris* in little else than in having a very marked, naked, zigzag, vertical groove between the two rows of plates of each interambulacral area, and one somewhat less distinct between the ranges of ambulacral plates. It includes about half a dozen species, which appear to be mainly confined to the colder regions of the southern hemisphere, although two of the species extend as far to the northward as the East Indies and Natal.

On the 28th of January, 1876, we dredged from the steam-pinnace, in about 10 fathoms water, off Cape Pembroke, at the en-

trance of Port William, East Falkland Island, a number of specimens of a pretty little species, *Goniocidaris canaliculata*, A. Agassiz (fig. 5). This species has a general resemblance, at a first glance, to *Cidaris papillata*, var. *stokesii*; but the radioles are

Fig. 5.



*Goniocidaris canaliculata*, Agassiz. Twice the natural size.

thinner and much shorter, and differ wholly in their sculpture; the shell is even more depressed; the secondary tubercles are more distant; and a very regular series of short club-shaped rays seated on miliary granules are interposed in the rows between the spines of the second order. The ovarian openings are extremely minute, and are placed close to the outer edge of the ovarian plates. The upper part of the test is quite flat, the flat space including not only the ovarian plates and the plates of the periproct, but the first pair, at least, of plates of each interambulacral area. Articulated to the primary tubercles of these latter are two circles of radioles, the inner more slender and shorter, the outer stouter and longer, but both series much larger than radioles usually are in that position on the test.

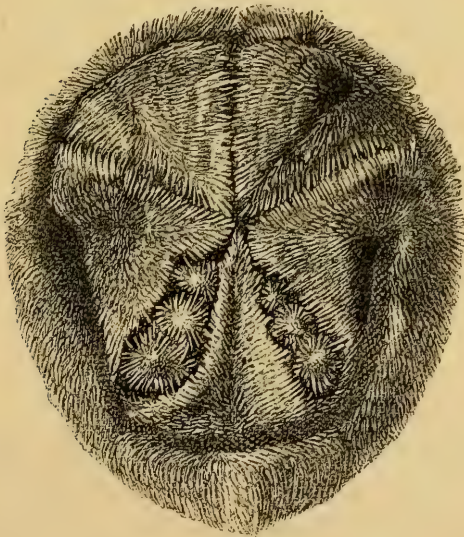
These special spines are cylindrical and nearly smooth, and they lean over towards the anal opening, and form an open tent for the protection of the young, as in *Cidaris nutrix*, but at the opposite pole of the body. In this species the eggs are extruded directly into the marsupium; and I imagine, from the very small size of the ovarial openings, that when they enter it, they are very minute, and probably unimpregnated. In the examples which we dredged at the Falkland Islands, the young were, in almost every case, nearly ready to leave the marsupium; we were too late in the season to see the earlier stages. The young in the same marsupium are nearly all of an age, some somewhat more advanced than others. The diameter of the test is from 1 to 1.5 millim., and the height about .8 millim.; the length of the primary spines is, in the most backward of a brood, .5 millim., while in the most advanced it equals the diameter of the test. The perisome, in which the cribriform rudiments of the plates of the corona and the young spines are being developed, is loaded with dark purple pigment, which makes it difficult to observe the growth of the calcareous elements. About thirty primary spines arise on the surface of the corona almost simultaneously in ten rows of three each: they first make their appearance as small papillæ covered with a densely pigmented ciliated membrane; and when they have once begun to lengthen, they run out very rapidly until they bear to the young nearly the same proportions which the full-grown spines bear to the mature corona. Very shortly some of the secondary spines, at first nearly as large as the sprouting primary spines, make their appearance in the interstices between these; and a crowd of very small spines rise on the nascent scales of the peristome. Successively five or six pedicellariæ are developed towards the outer edge of the apical area, which at this stage is disproportionately large; the pedicellariæ commence as purple papillæ, which are at first undistinguishable from young primary spines; the first set look enormously large in proportion to the other appendages of the perisome. Almost simultaneously with the first appearance of the primary spines, ten tentacular feet, apparently the first pairs on each ambulacrum of the corona just beyond the edge of the peristome, come into play; they are very delicate and extremely extensile, with well-defined sucking-disks; and with these the young cling to and move over the spines of the mother, and cling to the sides of the glass vessel, if they

are dislodged from the marsupium. This species seems to acquire its full size during a single season. We dredged it at the close of the breeding-season, and we took no specimens intermediate in size between the adult and the young.

### III. ECHINOIDEA PETALOSTICHA.

In shallow water, varying from 20 to 50 fathoms, with a muddy bottom, in Accessible Bay, Kerguelen's Land, we dredged on the 9th of January, 1874, from the steam-pinnace, innumerable Urchins very much resembling in general appearance *Brissopsis lyrifera*, the common Fiddle Urchin of the boreal province of the British seas. The group to which these Urchins belong requires careful revision; but it seems, from the absence of the subanal fasciole and from some other characters, that the species at present under consideration must be referred to the genus *Hemiaster*; and it is very probable, from its great abundance in ordinarily accessible depths, that it will turn out, on comparison, to be one of the species brought home by Sir James Clark Ross's Antarctic Expedition.

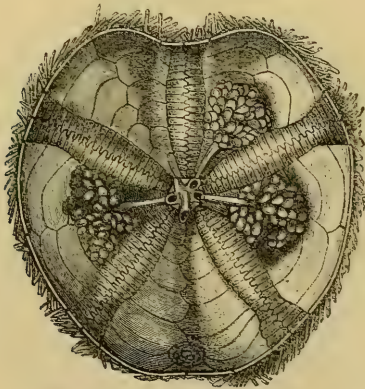
Fig. 6.



*Hemiaster*, sp. Twice the natural size.

The test of a full-sized example (fig. 6) is about 45 milims. in length and 40 millims. in width; the height of the shell in the female is 25 millims., in the male it is considerably less. The apex is nearly in the centre of the dorsal surface; the genital openings are three in number, in the female very large; the bilabiate mouth is placed well forward on the ventral aspect; and the excretory opening is posterior and supramarginal. The odd anterior ambulacrum is shallow and the tube-feet which are projected from it are large and capitate. The anterior paired ambulacra are somewhat longer than the posterior. The whole of the surface of the test is covered with a close pile of small spines of a dark green colour; those fringing the ambulacral grooves are long and slightly curved, and they bend and interdigitate so accurately over the ambulacra that one might easily overlook the grooves at a first glance. The peripetalous fasciole is somewhat irregular; but in those examples in which it is best defined, it forms a wide arch extending backwards on each side a little beyond the lateral ambulacra of the trivium, and then contracting a little, forms a rudely rectangular figure round the bivium. The paved ambula-

Fig. 7.

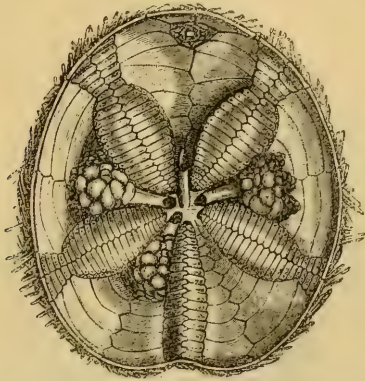


*Hemiaster*, sp. Apical half of the test of a male example, from within.  
Natural size.

cral grooves in the male are shallow, not much deeper than the anterior ambulacrum (fig. 7); in the female the pore-plates of

the paired ambulacra are greatly expanded and lengthened, and thinned out and depressed so as to form four deep, thin-walled, oval cups sinking into and encroaching upon the cavity of the test (fig. 8). The ovarian openings are, of course, opposite the inter-

Fig. 8.



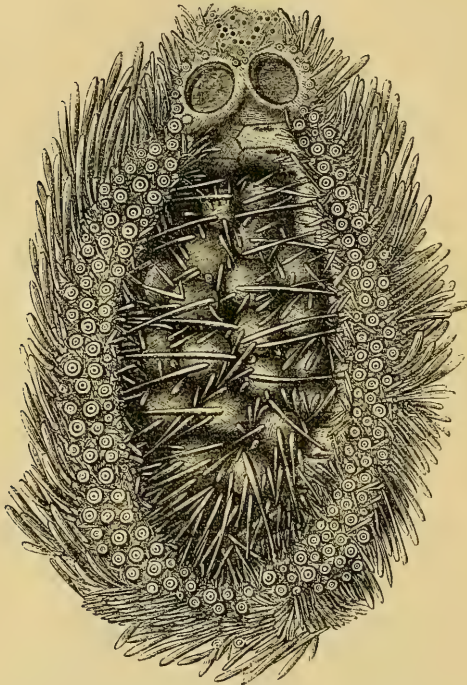
*Hemiaster*, sp. Apical half of the test of a female example, from within.  
Natural size.

radial areas ; but the spines are so arranged that a kind of covered passage leads from the opening into the marsupium ; and along this passage the eggs, which are remarkably large, upwards of a millimetre in diameter when they leave the ovary, are passed, and are arranged very regularly in rows on the floor of the pouch, each egg being kept in its place by two or three short spines which bend over it (fig. 9).

Among the very many examples of this *Hemiaster* which we dredged in Accessible Bay, and afterwards in Cascade Harbour, Kerguelen, there were young in all stages in the breeding-pouches ; and although from the large size and the opacity of the egg and embryo it is not a very favourable species for observation, had other conditions been favourable we had all the material for working out the earlier stages in the development of the young very fully. The eggs, on being first placed in the pouches, are spherical granular masses of a deep orange colour, enclosed within a pliable vitelline membrane, which they entirely fill. They become rapidly paler in colour by the development of the blastoderm ; and they increase in size probably by the imbibition of water into the

gastræa cavity; and a whitish spot with a slightly raised border indicates an opening which, I have no reason to doubt, is the permanent mouth; but of this I cannot be absolutely certain. The

Fig. 9.



*Hemiaster*, sp. The arrangement of the eggs in one of the marsupial recesses.  
Five times the natural size.

surface now assumes a translucent appearance, and becomes deeply tinged with dark purple and greenish pigment; and almost immediately, without any definite intermediate steps, the outer wall is filled with calcified tissue, it becomes covered with fine spines and pedicellariæ, a row of tentacular feet come into action round the mouth, the vent appears at the posterior extremity of the body, and the young assumes nearly the form of the adult. These later changes take place very quickly; but they are accompanied by the production of so much heavy purple and dark-green pig-



ment that it is difficult to follow them. The viscera are produced at the expense of the abundant yelk; and the animals at once take a great start in size by the imbibition of water into the pre-visceral cavity. The young Urchins jostle one another on the floor of the breeding-pouch, those below pushing the others up until the upper set are forced out between the rows of fringing spines of the pouch; but even before leaving the marsupium, on carefully opening the shell of the young, the intestine may be seen already full of dark sand, following much the same course which it follows in the adult. The size of the test of the young on leaving the marsupium is about 2.5 millims. in length by 2 millims. in width.

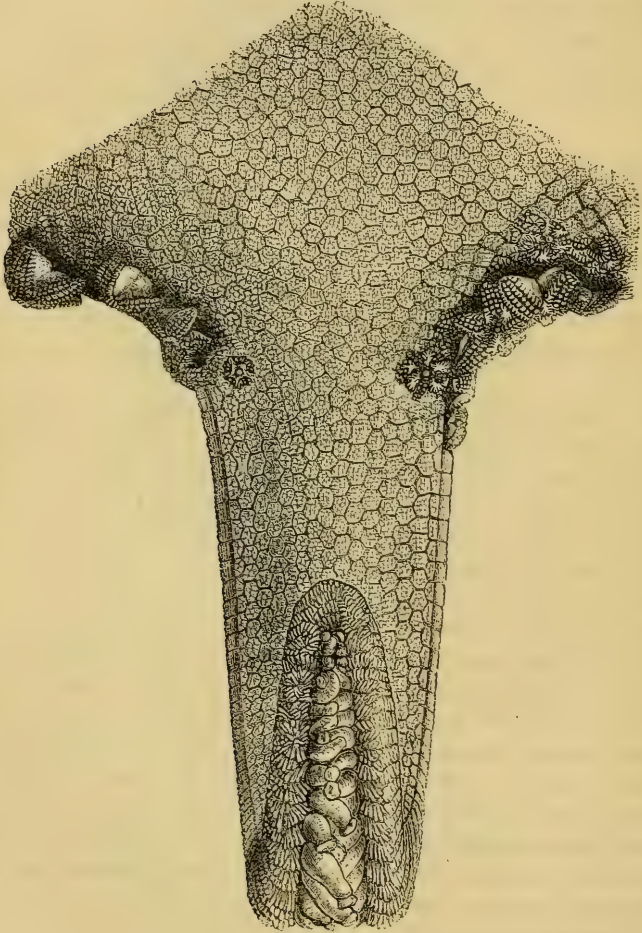
#### IV. ASTERIDEA.

On the 27th of January, 1874, at station 149, off Cape Maclear, on the south-east coast of Kerguelen Land, we dredged a handsome Starfish of the genus *Archaster* from a muddy bottom at a depth of 30 fathoms. As this species, which is not far removed from *A. andromeda* of the northern seas, appears to be undescribed, I will give it provisionally the name of *A. excavatus* (fig. 10).

A well-grown example is from 100 to 120 millims. in diameter from tip to tip of the arms; the length of the arm is about three times its width near the base, and three times the diameter of the disk. The pairs of marginal plates are long and narrow, running up with a slight curve outwards from the edge of the ambulacral groove until they meet the border of the dorsal perisome above; they are closely set with short blunt spines, which become gradually a little longer towards the radial groove; and at the edge of the groove each plate bears a tuft of about six rather long spines: these tufts in combination form a scalloped fringe spreading inwards on each side over the groove. The dorsal surface of the body is covered with a tessellated pavement composed of capitate paxilli. The heads of the paxilli in close apposition combine to form a mosaic with rudely hexagonal facets; and as they are raised upon somewhat slender shafts whose bases, like the plinths of columns, rest upon the soft perisome, arcade-like spaces are left between the skin and the upper calcareous pavement. The eggs pass into these spaces from the ovarian openings: on bending the perisome and separating the facets, they may be seen in numbers among the shafts of the paxilli. There is a continual dis-

charge of ova into the passages, so that eggs and young in different stages of development occupy the spaces at once. The young do not escape until at least six ambulacral suckers are formed on each arm; they may then be seen pushing their way out by forcing the paxilli to the side, and squeezing through the chink be-

Fig. 10.



*Archaster excavatus*, Wy. Thomson. Twice the natural size.

tween them. While it is extricating itself, the oral surface of the young is always above; and the centre of the star with the mouth is usually the part which first protrudes; then the arms disengage themselves one after another, many of the brood remaining for a time with one or two arms free and the others still under the paxilli. When the young have become disengaged, they remain for a considerable time attached to the parent by the centre of the dorsal surface. I could never satisfy myself by what means this is effected; the attachment is very slight, and they are removed by the least touch. In this attached stage, until they entirely free themselves, which they do when the number of tentacular feet on each arm has reached about twenty, they cluster in the reentering angles between the arms of the mother, spreading a little way along the arms and on the dorsal surface of the disk; the young escape from the marsupium chiefly in the neighbourhood of the angles between the rays. The madreporiform tubercle is visible in the young near the margin of the disk between two of the arms; but in the mature Starfish it is completely hidden by the paxilli, and no doubt it opens into the space beneath them.

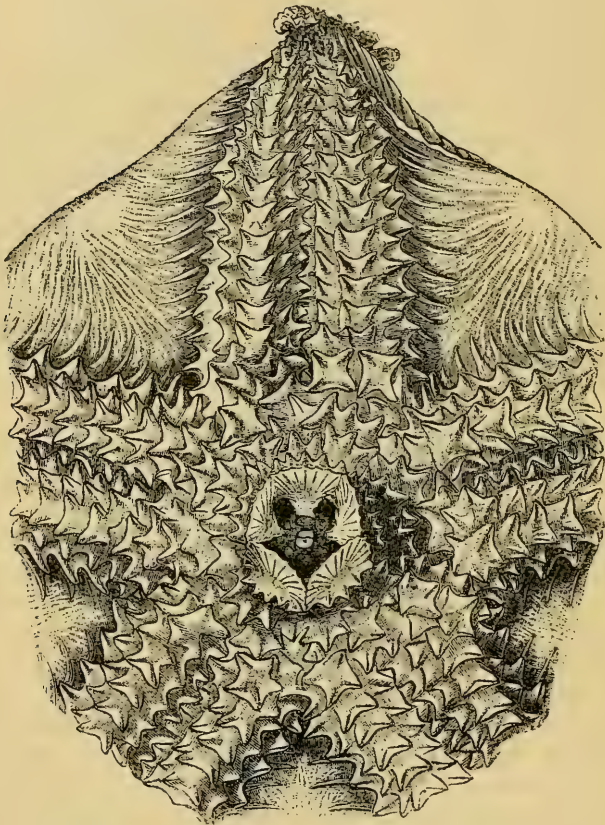
We took *Archaster excavatus* only on that one occasion; and the weather was so boisterous at the time that it was impossible to trace the early stages in the development of the embryo. It is evident that the process generally resembles that described by Professor Sars in *Pteraster militaris*; and it is quite possible that, while there is certainly not the least approach to the formation of a locomotive bipinnaria, as in that species some provisional organs may exist an early period.

In 'The Depths of the Sea' (p. 120) I noticed and figured a singular little Starfish from a depth of 500 fathoms off the north of Scotland under the name of *Hymenaster pellucidus*. This form was at that time the type of a new genus; but the researches of the last three years have shown that, with the exception perhaps of *Archaster*, *Hymenaster* is the most widely distributed genus of Asterids in deep water. It is met with (sparingly, it is true, only one or two specimens being usually taken at once in the trawl) in all parts of the great ocean; and it ranges in depth from 400 to about 2500 fathoms.

On the 7th of March, 1874, we dredged an extremely handsome new form, to which I shall give provisionally the name of *H. nobilis*,

in lat.  $50^{\circ} 1' S.$ , long.  $123^{\circ} 4' E.$ , 1099 miles south-west of Cape Otway, Australia, at a depth of 1800 fathoms, with a bottom of *Globigerina*-ooze, and a bottom-temperature of  $0^{\circ} 3 C.$  (station 158).

Fig. 11.



*Hymenaster nobilis*, Wy. Thomson. Half the natural size.

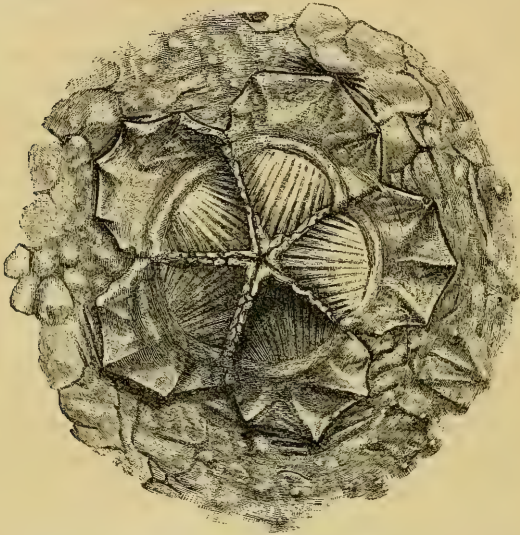
*Hymenaster nobilis* (fig. 11) is 300 millims. in diameter from tip to tip of the rays; the arms are 55 millims. wide; and, as in *H. pellucidus*, a row of spines fringing the ambulacral grooves are greatly lengthened and webbed; and the web running along the side of one arm meets and unites with the web of the adjacent arm, so

that the angles between the arms are entirely filled up by a fleshy lamina stretched over and supported by spines, the body thus becoming a regular pentagon. The arms are 55 to 60 millims. in diameter; the upper surface of the body, disk, and arms, all the surface, except the smooth membrane between the arms, is covered with fascicles of four to six diverging spines. These spines are about 3 millims. in height; and they support and stretch out a tolerably strong membrane clear above the surface of the perisome like the canvass of a marquee, leaving an open space beneath it. A close approach to this arrangement occurs also in *Pteraster*.

At the apical pole the upper free membrane runs up to and ends at a large aperture, 15 millims. in diameter, surrounded by a ring of five very beautifully formed valves. These valves do not essentially differ from the ordinary radiating supports of the marsupial tent; a stout calcareous rod arises from the end of the double chain of ossicles which form the floor of the ambulacral groove. From the outer aspect of this support three or four spines diverge in the ordinary way under the tent-cover; but from its inner aspect six or eight slender spines rise in one plane with a special membrane stretched between them. When the valves are raised and the pentagonal chamber beneath them open, these spines separate from one another, and, like the ribs of a fan spread out the membrane in a crescentic form (fig. 11); and when the valves close, the spines approximate and are drawn downwards, the five valves forming together a very regular, low, five-sided pyramid (fig. 12). Looking down into the chamber when the valves are raised, the vent is seen on a small projecting papilla in the centre of the floor; and between the supporting ossicles of the valves, five dark open arches lead into the spaces opposite the reentering angles of the arms, which receive the ducts of the ovaries. In the particular specimen to which I have referred, which is considerably the largest of the genus which we have yet met with, there were one or two eggs in the pouch; but they were apparently abortive. It seemed that the brood had been lately discharged; for some oval depressions still remained on the floor of the central chamber, in which the eggs or the young had evidently been lodged. I have on three occasions found the eggs beneath the membrane in the angles of the arms and, in a more advanced stage, congregated in the central tent, but never under circumstances such that I could keep and examine them; exposed

or loosely covered eggs or embryos, or any soft and pulpy organs or appendages are always in a half disintegrated state when they are brought up from such great depths, if they are not entirely washed away.

Fig. 12.



*Hymenaster nobilis*, Wy. Thomson. The marsupial chamber with the valves closed. Twice the natural size.

As I have already said, *Hymenaster* is closely allied to *Pteraster*: the arrangements of the marsupium are nearly the same in both; and it is highly probable that, as in *P. militaris*, a provisional alimentary tract may be developed in the early stages of the embryo.

There are several fine species of *Hymenaster* within reach of British naturalists in the deep water at the entrance of the Channel and off Cape Clear; but I fear there will be great difficulty in determining this point unless the genus turns up somewhere in shallower soundings where specimens can be taken alive.

#### V. OPHIURIDEA.

At station 194, at the entrance of Royal Sound, on the S.E. coast of Kerguelen Land, we dredged, on the 17th of January,

1874, a large number of specimens of a species of the genus *Ophiocoma* of which I can find no description; and I accordingly name it provisionally *O. didelphys* (fig. 13). We afterwards met with the same species in other localities among the fiords and bays of Kerguelen.

The disk is about 20 millims. in diameter; and the arms are four times the diameter of the disk in length. The disk is uniformly coarsely granulated; the arm-shields, which are well-defined through the membrane, are rounded in form and roughly granulated like the remainder of the disk. The character which at once distinguishes this species from all the others of the genus is, that the normal number of the arms is seven instead of five, which is almost universal in the class. The number of arms is subject to certain variation. I have seen from six to nine, but never fewer than six. The arm-spines are numerous and long. The general colour of the disk and arms is a dull greenish brown.

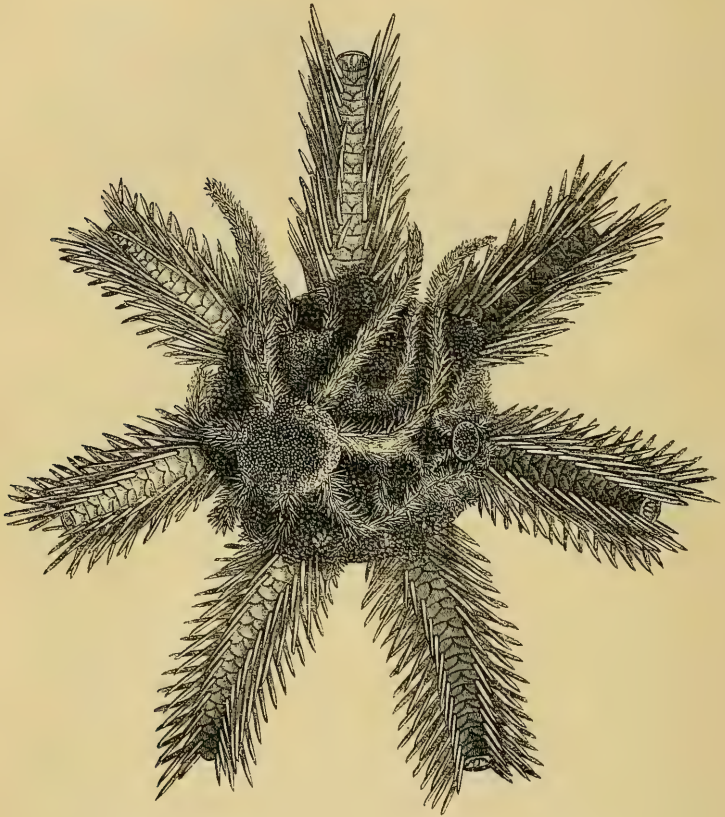
A large proportion of the mature females, if not all of them, had a group of from three to ten or twelve young ones clinging to the upper surface of the disk by their arms: the largest of these were about a quarter the size of their mother; and they graduated down in size until the smallest had a diameter of less than 1.5 millim. across the disk. The largest and oldest of the progeny were always uppermost, furthest from that disk, the series decreasing in size downwards, and the supply evidently coming from the genital clefts beneath. In several specimens which I examined, although by no means in all, there were groups of eggs and of young in still earlier stages, free in the body-cavity in the interbrachial spaces.

It thus seems that in this case the true "marsupium" is a portion of the body-cavity, and that the protection afforded by it is supplemented by the attachment of the young to the surface of the disk, maintained for some time after their extrusion or escape.

The process of propagation in *Ophiocoma didelphys* differs from most of the other cases described in the eggs being successively hatched, and the young being found consequently in a regularly graduated series of stages of growth. Although I had not an opportunity of working the matter out with the care and completeness I could have wished, I feel satisfied, from the examination of several of the young at a very early period, that in this case no

provisional mouth and no pseudembryonic appendages whatever are formed, and that the primary aperture of the gastrula remains as the common mouth and excretory opening of the mature

Fig. 13.



*Ophiocoma didelphys*, Wy. Thomson. Twice the natural size.

form. From the appearance of the ovaries and of the broods of young, I should think it probable that this species gives off young in a continuous series for a considerable length of time, probably for some months.

I have selected for illustration in the foregoing pages, out of a much larger number, eight examples representing four orders show-



the development of the young of Echinoderms from the egg without the intervention of a locomotive "pseudembryo." As I have already stated, I cannot, on account of the unfavourable conditions for carrying on such investigations under which the majority of the species were procured, say with certainty that no trace of pseudembryonic appendages or provisional organs exists in any of these instances; but I feel satisfied that none such occur in *Psolus ephippifer*, in the Kerguelen species of *Hemiaster*, or in *Ophiocoma didelphys*; nor am I in a position to affirm that in these high southern latitudes direct development is universal in the subkingdom. I believe, indeed, that it is not so; for species of the genera *Echinus*, *Strongylocentrotus*, and *Amblypneustes* run far south, and a marsupial arrangement seems improbable in any of these. It is, however, a significant fact that while in warm and temperate seas "Plutei" and "Bipinnariæ" are constantly taken in the surface-net, during our southern cruise between the Cape of Good Hope and Australia only one form of Echinoderm "pseudembryo" occurred; and that we regarded with some little doubt as the larva of *Chirodota*, from the presence of calcareous wheels in the skin.

South Atlantic,  
March 14, 1876.

*Note.*—Since this paper was written, several notices of these Kerguelen Echinoderms have appeared, both in this country and in America, in connexion with the preliminary reports of the naturalists attached to the Transit Expedition. As, however, this communication is only intended as a preliminary sketch of some of the peculiar phenomena of their propagation, and does not pretend to accuracy in nomenclature, I have thought it better to allow it to remain without alteration. When satisfactory descriptions and figures are published, it will be necessary to go into the whole question of synonymy in detail.—C. Wy. T.

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Contributions to the Ornithology of New Guinea.—Part I.  
Notes on a Small Collection of Birds from South-eastern New Guinea. By R. BOWDLER SHARPE, F.L.S.

[Read June 15, 1876.]

So much interest attaches to the natural history of New Guinea, that I am sure the Members of the Society will be pleased to see a few birds which have been forwarded to the British